Detection of the recent arrivals of *Ameles spallanzania* and *Miomantis paykullii* in various European countries through citizen science contributions

Kaan Yilmaz[1]*, Hasan Sevgili[2]*

1 Biotechnology Institute of Ankara University, Ankara, Turkiye.
2 Department of Molecular Biology and Genetic, Faculty of Art and Science, Ordu University, Ordu, Turkiye.

Corresponding author: Kaan Yılmaz (kyilmaz98@hotmail.com)

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Abstract

The presence of *Miomantis paykullii* has been identified for the first time in Türkiye, Cyprus, and Spain, while *Ameles spallanzania* has been identified for the first time in Slovakia, Romania, Luxembourg, and Türkiye. Records from social media and citizen science platforms suggest that the spread of these species may be influenced by human activities, particularly transportation and landscaping, similar to previously proposed hypotheses, as all observations were made in anthropogenic areas. Considering previous reports and new records related to these two species, researchers should pay attention to their ability to adapt easily to new regions and their potential to become invasive.

Keywords

Alien species, biodiversity, citizen scientists, Mantodea, non-native species, praying mantids

Introduction

In the Anthropocene era, human activities, such as trade, tourism, and transportation, rapidly change species distrubution (Hulme 2009, Seebens et al. 2018). As a result, some species have been transported far from their natural habitats and are breeding quickly in new areas (Richardson and Pyšek 2006, Bellard et al. 2012). Some of these species, which rapidly adapt to new locations and establish as invasive and alien species, cause serious damage to crops (Paini et al. 2016), while predator species such as *Miomantis caffra* Saussure, 1871 can cause negative impacts on native species through predation or niche competition (Fea 2011). According to recent studies, various praying mantis species have arrived in European countries from their native regions due to human activities and climate change (Schwarz and Ehrmann 2018, Anselmo et al. 2023), with citizen scientists and social media playing an important role in the early detection of new arrivals (Connors et al. 2022, Sevgili and Yılmaz 2022).

The genus *Miomantis* Saussure, 1870, which includes 73 species (Otte et al. 2025), has witnessed the recent expansion of two of its members beyond their native ranges. *Miomantis paykullii* Stål, 1871, originally from the Afrotropical region, including Egypt, the Sahara, and Mauritania (Ehrmann 2002), has been documented in Europe, specifically in Portugal (Marabuto 2014). Likewise, *M. caffra*, native to South Africa, has established itself as a non-native species in Portugal and California and an invasive species in New Zealand (Ramsay 1984, 1990, Marabuto 2014).

Contemporary investigations into *Ameles spallanzania* (Rossi, 1792) indicate that this species, once confined to the Western Alps, has rapidly spread across the Mediterranean region. Anthropogenic factors, like railway networks likely contribute to its dispersal (Anselmo 2022). Recent distribution data from Northern localities in Europe further support the notion that human activities are driving the range expansion of *A. spallanzania* (Battison and Buzzetti 2012, Battiston et al. 2020). Moreover, the northward migration of this thermophilic species may be linked to climate change (Battiston et al. 2020).

In this study, we aimed to identify newly introduced northern populations of the thermophilic alien species *A. spallanzania* and *M. paykullii* in several countries in Europe via citizen science and social media platforms and to discuss the probable scenarios of their expansion routes based on recent observations and existing literature. Additionally, we underscore the pivotal role of social media and citizen science platforms in the early detection of invasive/alien species dispersal, evaluating both local and citizen-sourced data and drawing attention to the adaptive capacity of these two species.

Materials and methods

Data collection from networks and observers.—Data for this study were gathered by examining records of these insects on social media (Instagram), aggregating databases (GBIF), and citizen science platforms (iNaturalist). In an initial examination of the literature, it

* Both authors contributed equally to this work.

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was found that *A. spallanzania* had not been previously reported in Slovakia, Romania, Luxembourg, Türkiye, and *M. paykullii* had not been reported in Türkiye, Spain, and Cyprus. *M. paykullii* and *A. spallanzania* were identified via photographs from citizen scientists and social media platforms using the criteria of Battiston et al. (2010). To prevent misidentification, the researchers also reviewed records of potentially confusable species and included them in the compiled location data. If the individual who made the record of the sighting was reachable, information such as the location and photographs were requested. After records with clear location information and photos from these regions were identified on social media (Figs 1A, B, G, F, 2) and iNaturalist (Fig. 1C, D, I), the authors obtained the photos from the record owners along with permission for their use here.

Miomantis paykullii *findings.*—A single female specimen (Fig. 3A) was collected from a building adjacent to an artificial garden (Fig. 3D) in Fener, Muratpaşa district, Antalya, Türkiye. The collection site is located at 36.85631953°N, 30.76260351°E, and has an elevation of 48 m. The female specimen was collected on July 7, 2024 by Gökçe Coşkun. After the specimen was identified based on photos, the female specimen was sent to the authors for species confirmation and inclusion in the collection of the authors. Following its transfer to captivity, the female laid an ootheca, from which 21 nymphs emerged. After observations of the adult specimen, oothecae, and nymph samples, they were transferred into 96% alcohol for future studies.

An adult male specimen (Fig. 1A) was recorded on the balcony of an apartment in Muratpaşa, Antalya, on September 3, 2021 by Semra Bozkurt at the coordinates 36.8969°N, 30.7133°E. The location of the sighting was obtained by contacting the record owner via Instagram.

A single nymph specimen (Fig. 1C) was recorded on the wooded wall of a garden in a hotel. The specimen was observed in Ulupınar, Kemer, Antalya on May 9, 2023 by Olga Minorenko at the coordinates 36.40565°N, 30.47474°E. The location was confirmed by contacting the record owner via iNaturalist (https://www.inaturalist.org/observations/161042283).

An adult male specimen (Fig. 1B) was recorded on a picnic desk at Akdeniz University in Pınarbaşı, Konyaaltı, Antalya on June 19, 2023 by Nağme Bulut at the coordinates 36.89906°N, 30.65547°E. The location of the report was obtained by contacting the record owner via Instagram.

An adult female specimen (Fig. 1H) was recorded in a house at night in İskenderun, Hatay on August 18, 2021 by Arda Kaan Azab at the coordinates 36.561123°N, 36.150003°E. The location of the report was obtained by contacting the record owner via Instagram.

Two adult female specimens (Fig. 1E, F) were recorded on the landscape vegetation at the gate of Larnaca Airport, Larnaca, Cyprus, on August 3, 2023 by Luca Rohr at the coordinates 34.86950°N, 33.60994°E. According to information obtained from the observer, several nymph and adult specimens were observed. The location of the report was obtained by contacting the record owner via Instagram.

A single adult female and a male nymph (Fig. 1D–I) were recorded in an area surrounded by agricultural areas and buildings in Salobreña, Spain, on October 20–26, 2022 by Alfonso Gómez at the coordinates 36.72369°N, -3.56222°E. The location was confirmed by contacting the record owner via iNaturalist (https://www.inaturalist.org/observations/142904382).

Ameles spallanzania *findings.*—Adult female and male specimens were recorded exhibiting sexual cannibalism behavior on a plant (Fig. 2A, B) located near a parking lot in Germánska, Šaľa, Slovakia, on September 8, 2024 by Adam and Igor Hlavatý at the coordinates 48.16146°N, 17.89005°E. The location was confirmed by contacting the record owner via iNaturalist (https://www.inaturalist.org/observations/240577532).

A nymph of *A. spallanzania* specimen (Fig. 2C) was recorded in the garden of a house in Koerich, Luxembourg, on October 18, 2024 by Paul Weinandt at the coordinates 49.6617°N, 5.97921°E. The location was confirmed by contacting the record owner via iNaturalist (https://www.inaturalist.org/observations/247912320).

A single adult female specimen (Fig. 2D) was found on the wall of a building in Tulcea, Romania, on September 20, 2024 by Oana Moraru, at the coordinates 45.17846°N, 28.79655°E. The location was confirmed by contacting the record owner via iNaturalist (https://www.inaturalist.org/observations/243318871). Another adult female specimen (Fig. 2F) was observed in Virsolt, Sălaj, Romania, on September 13, 2024 by Nikolett Kalydy on the rail of a building's terrace. The exact location was confirmed by contacting the record owner via iNaturalist (https://www.inaturalist.org/observations/241445024).

A single adult female specimen (Fig. 2E) was recorded in a garden near the seashore in Büyükçekmece, Istanbul, Türkiye, on August 30, 2019 by Atilla Şengör at the coordinates 41.03914°N, 28.42803°E. The location of the report was obtained by contacting the record owner via Instagram.

Data organizing and mapping.—To create a distribution map (Fig. 4) of these species, data were obtained from GBIF on *M. paykullii* from 1961 to October 22, 2024, and data on *A. spallanzania* from 1882 to October 22, 2024. Following this, the data obtained from

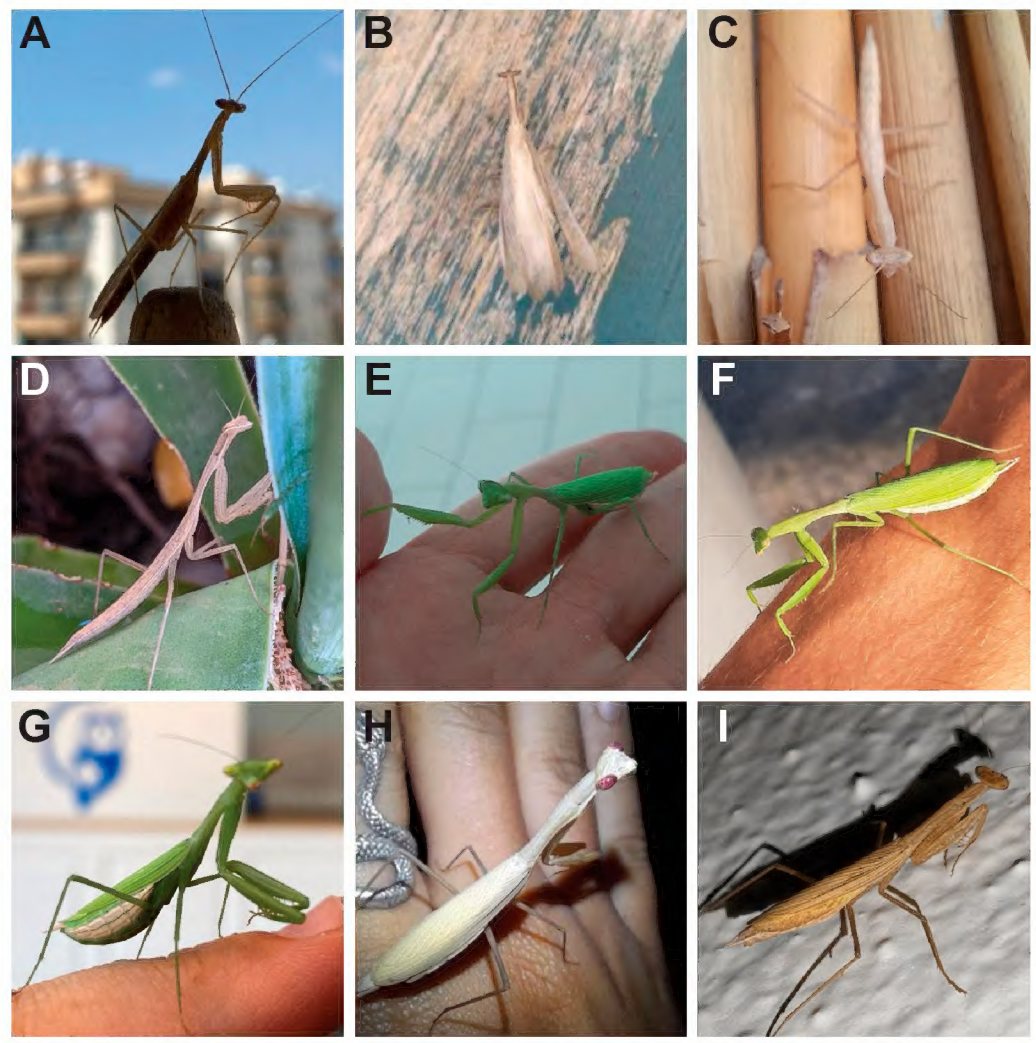

Fig. 1. Contributions of citizen scientists to the documentation of the invasive alien range expansion of *Miomantis paykullii* with observations from Antalya, Türkiye, Spain and Southern Cyprus; **A.** Adult male from Türkiye; **B.** Adult male from Türkiye; **C.** Adult female from Türkiye; **D.** Female nymph from Spain; **E.** Adult female from South Cyprus; **F.** Adult female from South Cyprus; **G.** Adult female from Türkiye; **H.** Adult female from Türkiye; **I.** Adult female from Spain.The photos were taken by Semra Bozkurt (**A**), Nağme Bulut (**B**), Olga Mironenko (**C**), Alfonso Gómez (**D–I**), Luca Rohr (**E, F**), Gökçe Coşkun (**G**), and Kaan Azab (**H**).

social media and observers was supplemented with records collected from citizen scientist platforms and GBIF. Data from social media (Instagram), citizen science platforms (iNaturalist), GBIF, and literature without a time distinction were gathered and included to show the current and existing distributions of the species. For *A. spallanzania*, 24% of the recorded locations were obtained from the literature and preserved specimen records, while 76% were sourced from citizen science platforms and social media. For *M. paykullii*, 9% of the recorded locations were obtained from the literature and preserved specimen records, while 91% were sourced from citizen science platforms and social media. Before mapping, location data collected for both species were categorized into two sections—'Reported' and 'Unreported'—based on whether they are reported in the the country's literature or not to make it easier to distinguish them on the map (Fig. 4). Using all the location data obtained, a map was generated using QGIS v. 3.16.14 (QGIS Development Team 2021). Photos of the female *M. paykullii* specimen (Fig. 3A) provided by the collector, as well as the first-instar nymph (Fig. 3B), emerged from ootheca and hatched ootheca (Fig. 3C) obtained from the same adult female specimen in captivity were taken using a Canon EOS 6D DSLR camera equipped with a Sigma 150 mm APO DG f/2.8 Macro Lens. All the images were edited with PhotoScape X.

Results

The data for this study focused solely on the current distribution of thermophilic *M. paykullii* and *A. spallanzania* (Fig. 4). According to our extensive search of citizen science platforms, social media, and the existing literature, no records of *A. spallanzania* in Türkiye existed before 2019. In Slovakia, Romania, and Luxembourg, no records existed before 2024. Based on our search, the earliest records of *M. paykullii* in Cyprus, Türkiye, and Spain are from 2019, 2021, and 2022, respectively. All specimens for both species were observed in urban areas such as parks, parking lots, gardens, and buildings.

Thus, *A. spallanzania* was identified as a new record in Türkiye, Romania, Slovakia, and Luxemburg, while *M. paykullii* was identified as a new record for Türkiye, Spain, and Cyprus. The distribution map (Fig. 4) indicates previously unrecorded locations (Fig. 4) using different symbols.

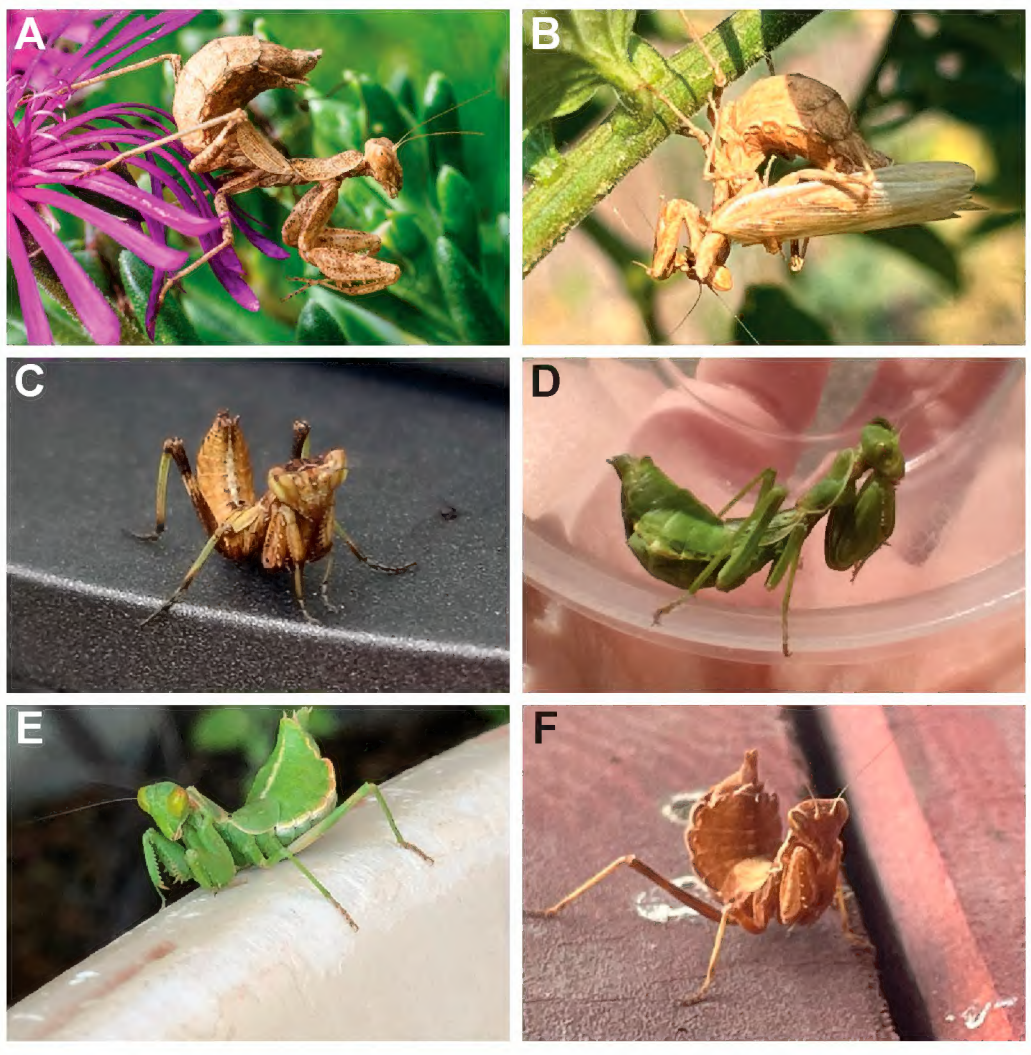

Fig. 2. Contributions of citizen scientists to the documentation of the expansion of *Ameles spallanzania* from Slovakia, Luxembourg, Romania, and Türkiye; **A.** Adult female from Slovakia; **B.** Recorded sexual cannibalism behavior from Slovakia; **C.** Nymph from Luxembourg; **D.** Adult female from Romania; **E.** Adult female from Türkiye; **F.** Adult female from Romania. The photos are taken by Igor Hlavatý (**A**), Adam Hlavatý (**B**), Paul Weinandt (**C**), Oana Moraru (**D**), Atilla Şengör (**E**), and Nikolett Kalydy (**F**).

Discussion

In recent years, some mantid species have been moving north due to global climate change, while many non-native species are also spreading through trade routes and human activities (Shcherbakov and Govorov 2020). Previous research has shown that various species of tropical insects and spiders are frequently recorded in ports and gardens (Rozwałka et al. 2017). According to Battiston et al. (2020), it is unlikely that *A. spallanzania*, which is sedentary and adapted to specific habitats, will expand its range through migration. A recent integrated study by Anselmo et al. (2023) suggested that the northern expansion of *A. spallanzania* could be related to global warming. However, this hypothesis must be tested with data from newly detected distribution areas. In addition to the effects of climate change, human activities, such as railways, may play a significant role in expanding this species (Battiston et al. 2020). The fact that new populations can only form through oothecae laid by females, that females have shorter wings and more limited movement than males (Battiston and Galliani 2011), and that most new records come from areas close to human settlements supports the hypothesis that *A. spallanzania* is spreading mainly due to anthropogenic factors. Nonetheless, recent reports have found that it has quickly expanded its distribution in various anthropogenic areas of Europe in recent years. To date, records in the literature related to the range expansion of *A. spallanzania* have come from Germany (Schwarz and Ehrmann 2018), Hungary (Szinetár and Kenyeres 2020), France and Switzerland (Borer et al. 2023), and Bulgaria (Vasilev et al. 2023). According to the findings of our study, the species has expanded its distribution to Slovakia, Türkiye, Luxembourg, and Romania. According to the data obtained for this study, records related to the spread of *A. spallanzania* are limited to the European side of Türkiye. Considering that the Bosphorus is a geographical isolation factor for the expansion of this species between the Anatolian and Thracian regions, obtaining a record from Anatolia in the future could provide important insights into the impact of anthropogenic factors on the *A. spallanzania* spread dynamics.

Considering the dense railway network in this region, the record we found in the Thracian part of Istanbul may suggest that the expansion could have occurred through the Balkans via the railway to Bulgaria. However, it should also be noted that no record of *A. spallanzania* has been found between Istanbul and Bulgaria. This finding supports the hypothesis that human-related transportation contributes to their range expansion. According to the information provided by the record owner from Slovakia, a car trip was made to Croatia in 2022 (a known native range for *A. spallanzania*), and, in addition to the recorded individual, two more individuals were observed around the parking lot. The record we obtained from Slovakia, where both males and females were found together and mating behavior was observed (Fig. 2B),

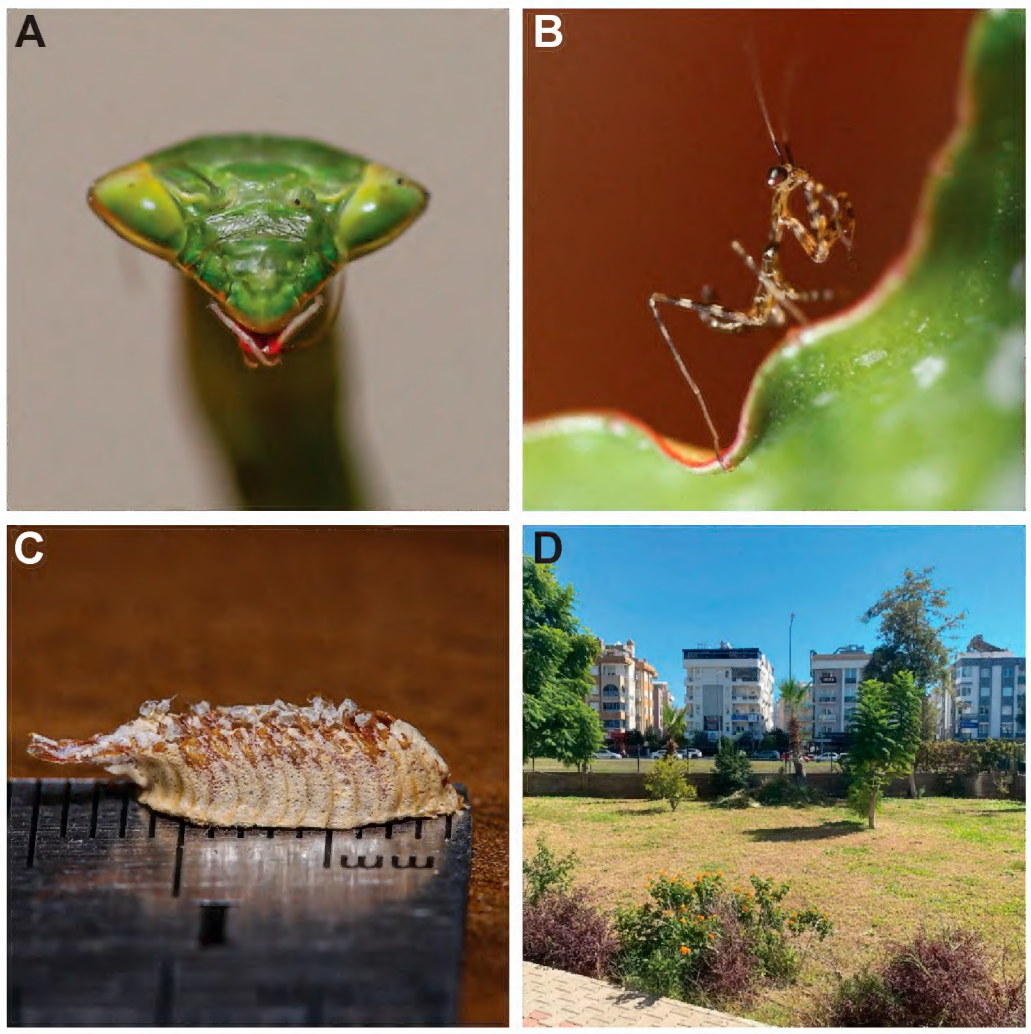

Fig. 3. A female *Miomantis paykullii* specimen collected from Antalya, Türkiye, and its ootheca and newly emerged first-instar nymph from the ootheca obtained in captivity; **A.** Female adult specimen head; **B.** 1st instar nymph emerged from ootheca in captivity; **C.** Hatched ootheca laid by adult female sample; **D.** The location of the sighting of *M. paykullii* in Antalya. The photos were taken by Kaan Yılmaz (**A–C**) and Gökçe Coşkun (**D**).

along with the record of a nymph in Luxembourg in October (Fig. 2C), may indicate the presence of established populations in both regions. This finding suggests that although *A. spallanzania* is known to spend the winter as a nymph in warm, southern latitudes (Battiston and Galliani 2011), it could also spend the winter as a nymph in northern latitudes due to climate change. It also suggests that *A. spallanzania* can overwinter as a nymph in northern latitudes. Regarding Eastern Europe, the earliest records of *A. spallanzania* expansion are from Bulgaria in 2016 (Vasilev et al. 2023), while the species was first recorded in Türkiye in 2019.

Based on a recent study (Vasilev et al. 2023), our data obtained from Romania and Türkiye represent the second observation of *A. spallanzania* in the Black Sea region and the first in Romania and Türkiye. According to the data obtained from our study, the fact that the species has also been recorded from Romania and Türkiye suggests that its distribution in the Balkans may be wider than previously known.

According to Ehrmann (2002) and Battiston et al. (2010), the known northern distribution of *M. paykullii* was limited to Egypt and Israel; however, the first and only record in the Mediterranean region occurred when Marabuto (2014) documented two males in Portugal. Since then, there have been no published records from other Mediterranean countries. Based on data collected from citizen science and social media platforms, the first record from Cyprus was reported in 2019, while for Türkiye, it was in 2021. The records from Türkiye were only from urban areas on different sides of the Eastern Mediterranean coast, specifically the Antalya and Hatay provinces. According to the available data, no records of *M. paykullii* have been found yet in the region between Hatay and Antalya (Mersin and Adana provinces). South Cyprus records were similar to urban areas, such as airports and urban gardens. The

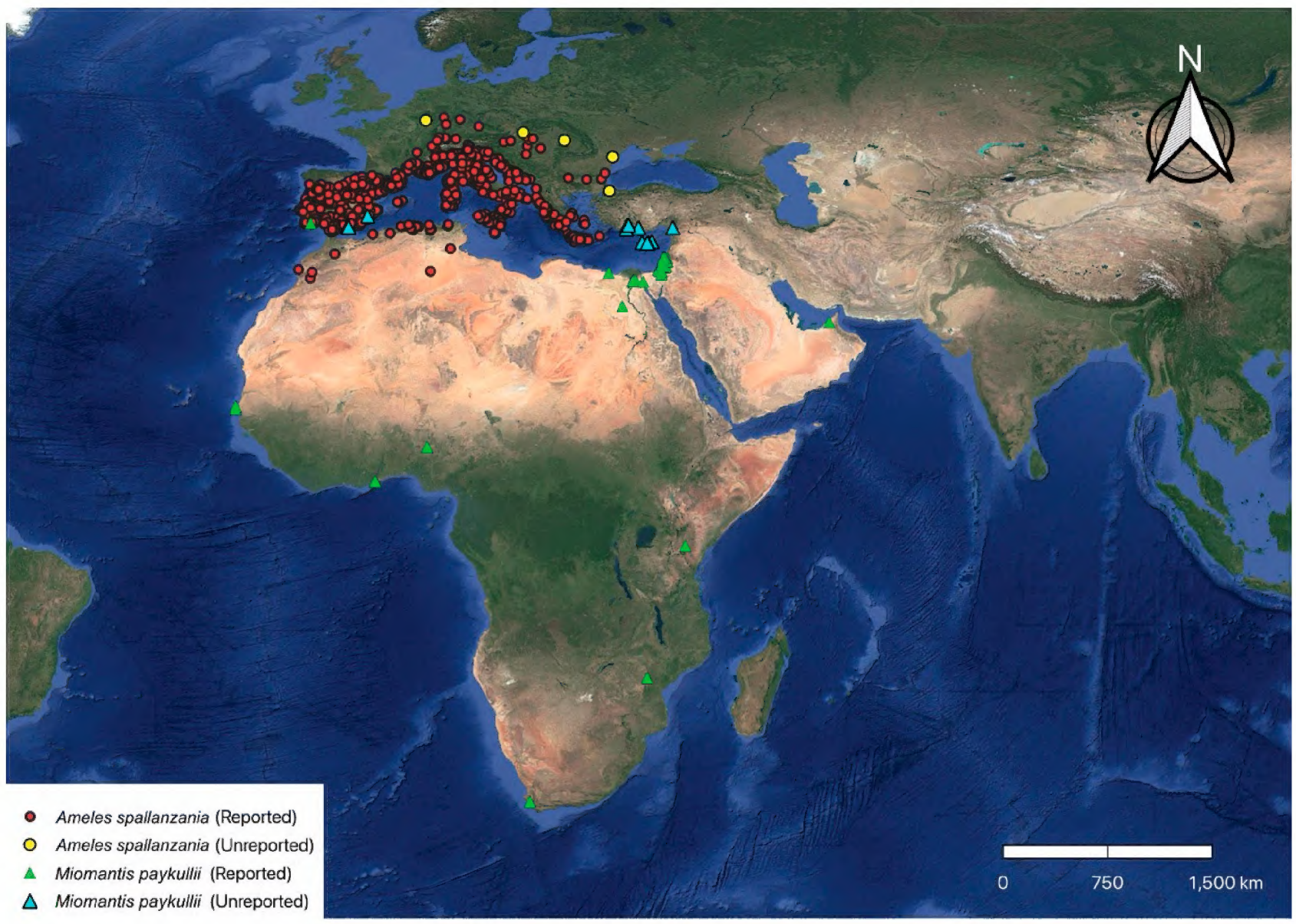

Fig. 4. Current distribution of *Ameles spallanzania* and *Miomantis paykullii* based on data obtained from social media (Instagram), citizen science platforms (GBIF and iNaturalist), and the literature. Reported: Locations reported in the literature; Unreported: Locations based on citizen science.

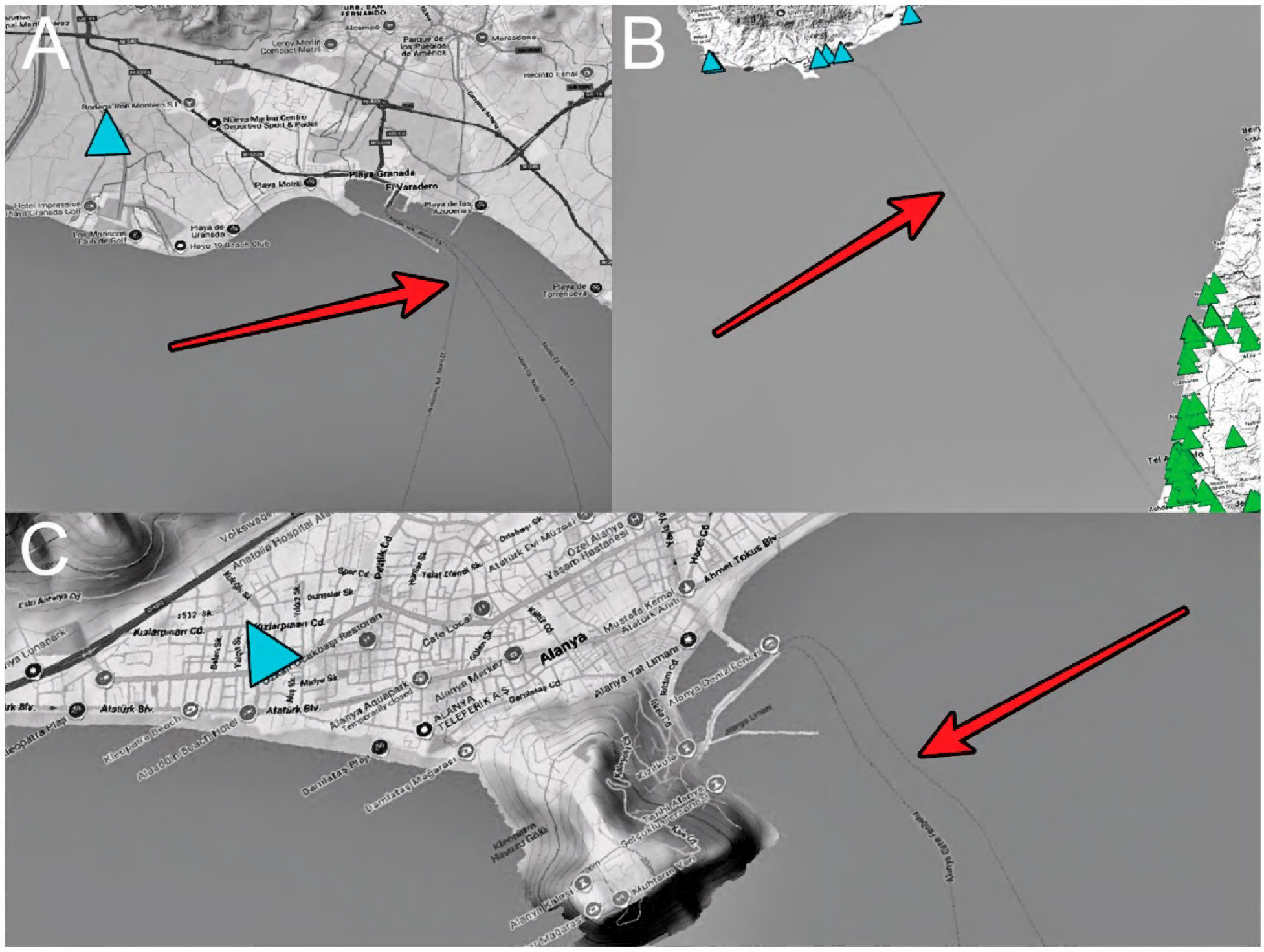

Fig. 5. Records of *M. paykullii* near sea routes, including both new localities and native distrubutions; blue triangles indicate newly recorded locations of *M. paykullii*, green triangles represent locations within its native distribution, red arrows show potential sea dispersal routes. **A.** Location of specimens and port of Motril-Granada, Spain; **B.** Location of specimens and the shipping route from Cyprus to Jerusalem, Israel (native area for *M. paykullii*); **C.** Location of specimens and the shipping route from Antalya, Türkiye to Northern Cyprus.

recording of *M. paykullii* from the Port of Limassol in Cyprus and other nearby urban areas suggests that this new population may have arrived via maritime transportation from Israel, where the natural population is located. This theory is supported by the presence of a sea route between Southern Cyprus and Israel (Fig. 5B). Similarly, the records from Antalya (Türkiye) and Motril (Spain), which are close to port areas, further strengthen this hypothesis.

Additionally, there is a maritime transportation route between Antalya and Cyprus (Fig. 5A). The possibility of *M. paykullii*'s expansion being the result of human means of transportation was also suggested by Schwarz and Ehrmann (2018). Additionally, there is a direct active sea route from Israel to Salerno, Italy. On the other hand, although there is seaway transportation from Israel to Istanbul (Türkiye) ports, no records of *M. paykullii* have been found in these northern latitudes. The species has only been detected in some costal localities in the Mediterranean regions. This may suggest that climate factors have a limiting effect on the distribution of this species.

In conclusion, while there is no geographical barrier among the new records of *A. spallanzania*, distinct barriers exist between the new records of *M. paykullii* in Spain and Cyprus and its native range. This situation may indicate that the two species have different spread dynamics. While *A. spallanzania* shows a distribution pattern with geographical continuity across Europe under the influence of anthropogenic and climatic factors, *M. paykullii* is transported to new geographical regions primarily through anthropogenic factors. New records from citizen science and social media platforms are expected to help uncover the factors driving the spread dynamics of these two species and guide future scientific studies. Lastly, given previous reports that *M. caffra* (The springbok mantis), which is non-native to Australia, preys on the native mantis *Orthodera novaezealandiae* (Colenso, 1882) (Fea 2011, Fea et al. 2013). It is crucial to monitor the spread of *A. spallanzania* and *M. paykullii* through citizen science and social media platforms, assess its impact on other native species using future records, and take necessary precautions.

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Supplementary material 1

Author: Kaan Yılmaz, Hasan Sevgili
Data type: xlsx
Explanation note: Coordinate datas from platforms. Data obtained from GBIF, social media, and citizen science platforms for mapping purposes.
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Link: https://doi.org/10.3897/jor.34.140630.suppl1

Supplementary material 2

Author: Kaan Yılmaz, Hasan Sevgili
Data type: scv
Explanation note: Records table.
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